Rock Creek – Croy Creek Water Quality Report

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Introduction

Rock Creek and Croy Creek both originate in the Smokey Mountains about ten miles southwest of Hailey, Idaho. Both are tributaries to the Big Wood River above Magic Reservoir. Rock Creek drains approximately 26,000 acres; Croy creek drains roughly 23,000 acres. Primary activities within both drainages include livestock grazing, farming, urban-rural housing, and recreation. Springtime runoff, generally occurring in late March, dominates the flow regimens of these basins; however, springs located in the upper watersheds sustain both streams through the summer months. Agricultural diversions also significant impact stream flows within the basins. Combined land ownership in the area is: BLM (47.7%), private (42.4%), State of Idaho (8.4%), U.S. Forest Service (1.3%), and Idaho State Fish and Game (0.1%).

Rock Creek is listed for sediment, nutrients (nitrates and phosphorous), bacteria, temperature, and flow alteration. Croy Creek is listed for sediment, nutrients, and flow alteration on the State of Idaho's 303(d) list (Buhidar, 2002). Table 1 relates the Big Wood River Total Maximum Daily Load (BWR TMDL) targets for pollutants examined in this study.

Table 1. Applicable TMDL Water Quality Targets.

Pollutant	Water Quality Targets
Sediment *(Croy & Rock Cr.)*	40 mg/L daily maximum 25 mg/L average monthly
Phosphorous *(Croy & Rock Cr.)*	0.08 mg/L daily maximum 0.05 mg/L average monthly
Temperature *(Rock Cr.)*	22 ^{o}C instantaneous, 19 ^{o}C daily average
Bacteria *(Rock Cr.)*	406 Colony Forming Units (CFUs)/ 100 mL instantaneous

Monitoring Request

In 2007, the Blaine Soil Conservation District (SCD) requested that the Idaho Association of Soil Conservation Districts (IASCD) collect water quality information in the Croy Creek and Rock Creek drainages in cooperation with the Wood River Land Trust (WRLT), and the Idaho Department of Environmental Quality (IDEQ).

Rock Creek and Croy Creek are currently undergoing major land use changes. Much of the agricultural land has been divided into subdivisions and 5-acre ranchettes. These changes could have a noticeable impact on water quality within these watersheds.

Three sites on Rock Creek and five sites in the Croy Creek drainage were selected to provide IDEQ with data to apply to its five-year TMDL review. Data will also be used for a WRLT proposed project that would expand an existing wetland at the south end of Lions Park in the lower portion of Croy Creek near Hailey, Idaho. The scope of the WRLT project included cleaning and expanding an existing wetland to help better serve the local community and wildlife. WRLT requested that monitoring be conducted at the outlet of this wetland both before and after the project. The WRLT wetland has since been completed and monitoring on Croy Creek at this location is scheduled to resume in 2009.

IASCD will work with the Blaine SCD, WRLT, the Mid-Snake Watershed Advisory Group (WAG), the Idaho State Department of Agriculture (ISDA), IDEQ, and private landowners to meet the following objectives:

- Assess existing water quality conditions within the area.
- Determine sediment, total phosphorous, and bacteria loads in the area.
- Conduct riparian assessments to determine existing conditions and areas of concern.
- Evaluate Best Management Practices (BMP) effectiveness.
- Use the data for public awareness.

Monitoring Program

Water quality monitoring began in April 2007 and continued through May 2008. All sites were monitored biweekly spring through fall and monitored once a month through the winter when accessible (Table 2; Figure 1). Suspended sediment concentrations (SSC), total phosphorous (TP), dissolved phosphorous (DP), and *E. coli* bacteria samples were taken at all sites. Inorganic nitrogen (nitrates) was also collected at the beginning of this study; however, due to non-detectable or near non-detectable levels at all sites, nitrate testing was discontinued.

Table 2. Monitoring site descriptions.

Site	Location
RC-1	100 meters south of Highway 20
RC-2	3 stream miles north of Highway 20
RC-3	50 meters below confluence of East/West Fork Rock Creek
CC-1	30 meters above confluence with the Big Wood River
CC-2	10 meters below road crossing at Gilman Flat above confluence with Bullion Gulch
DG	5 meters below Croy Creek road crossing
BG	10 meters below Croy Creek road crossing
CG	10 meters below Croesus Gulch road crossing

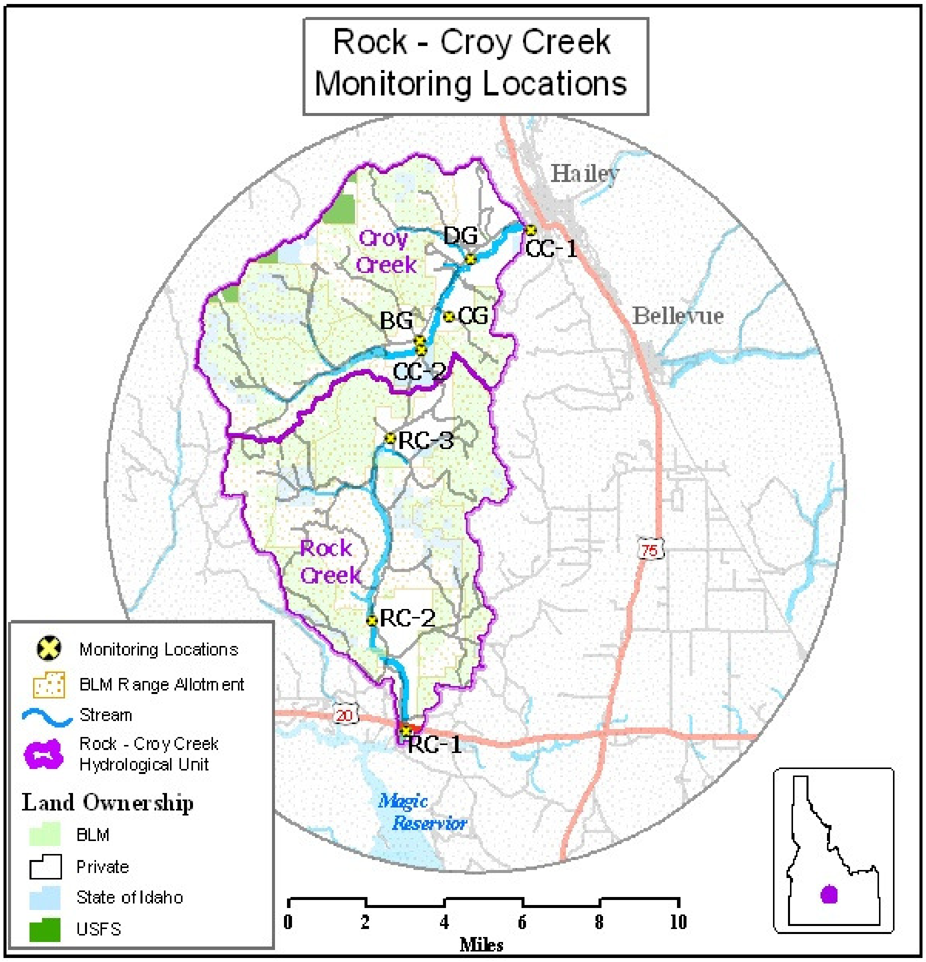

Figure 1. Monitoring site locations.

Sampling Methods

Water quality samples were collected by grab sampling directly from the source. Sampling sites were located away from obstructions to avoid backwater effects within the channel. For shallow creeks, six one liter grab samples were collected from a well-mixed section, near mid-stream at approximately mid-depth. For larger creeks, multiple grab samples were collected at equal intervals across the cross section and vertically integrated using a DH-81 sampler to provide a representative sample.

Except for bacteriological samples, grab samples for each site were composited into a 2.5-gallon polyethylene churn sample splitter. The composite sample was then thoroughly homogenized and poured off into properly prepared sample containers. For samples requiring filtration (dissolved phosphorous), a portion of sample was transferred into a vacuum unit and pressure-filtered through a 0.45 µm filter. The resultant filtrate was transferred directly into a properly prepared sample bottle.

Nutrient samples that required preservation were transferred into 500 mL sample containers containing sulfuric acid (pH <2). The polyethylene churn splitter was always thoroughly rinsed with source water at each location prior to sample collection. Bacteriological samples were collected directly from midstream into properly prepared sterile sample bottles. Parameters, analytical methods, preservation and holding times are included below in Table 3.

Table 3. Holding times and methodologies.

Parameter	Sample Size	Preservation	Holding Time	Method
Suspended Sediment Concentration	1 L	Cool 4°C	7 days	EPA 160.2
Total Phosphorous	200 mL	Cool 4°C, H_2SO_4	28 days	EPA 365.4
Ortho Phosphate	100 mL	Filtered, Cool 4°C	24 hours	EPA 365.1
Escherichia Coli	200 mL	Cool 4°C	30 hours	EPA 1105E
Nitrate	200 mL	Cool 4°C, H_2SO_4	28 days	EPA 352.3

All sample containers were marked to indicate station location, sample identification, date, and time of collection. All sample containers were placed on ice in a cooler until delivery to Analytical Laboratories in Boise, Idaho for analysis.

Field Measurements

Field measurements for temperature, dissolved oxygen (DO), conductivity, discharge, and a visual assessment of turbidity were performed at each site. Calibration of all field equipment was in accordance with the manufacture specifications. Field measurements, equipment and calibration techniques are listed in Table 4.

Table 4. Equipment Calibration Parameters.

Parameter	Equipment	Calibration
Dissolved Oxygen	YSI Model 55	Ambient air calibration
Temperature	YSI Model 55	Centigrade thermometer
Conductance and TDS	Orion Model 115	Conductance standards
pH	Corning Model 313	Standard buffer (7,10) bracketing for linearity

Stream Flow Measurements

Flow measurements were collected using a Marsh McBirney Flow Mate Model 2000 flow meter. The six-tenth-depth method (60% of the total depth below water surface) was used when the depth of water was less than three feet. For depths greater than 3 feet, the two-point method (20% and 80% of the total depth below the water surface) was used. At each station, a transect line was set up perpendicular to flow across the width of the creek. The discharge was computed by addition of the products of the flow cross-sections and the 30-second average velocities for each of those sections. Results are expressed in cubic feet per second (cfs).

Quality Assurance and Quality Control (QA/QC)

Analytical Labs uses EPA approved and validated methods. Laboratory QA/QC results generated from this project can be provided upon request. QA/QC procedures from the field-sampling portion of this project consisted of duplicates (at least 10% of the sample load) along with blank samples (one set per sampling event). The field blanks consist of laboratory grade deionized water transported to the field and poured off into prepared sample containers. The blank sample was used to determine the integrity of the field team's handling of samples, the condition of the sample containers supplied by the laboratory, and the accuracy of the laboratory's methods. Duplicates consist of two sets of sample containers filled with the same composite water from the same sampling site.

Results

Discharge

The highest recorded discharge during this study for Rock Creek was 19.7 cfs at RC-1 on April 21, 2008; the highest discharge in Croy Creek was 4.4 cfs at CC-1 on June 6, 2007 (Figure 2). Because monitoring was performed every other week through the spring and summer, these peaks are probably somewhat conservative. Flows quickly diminished to base flow levels by early June in both basins.

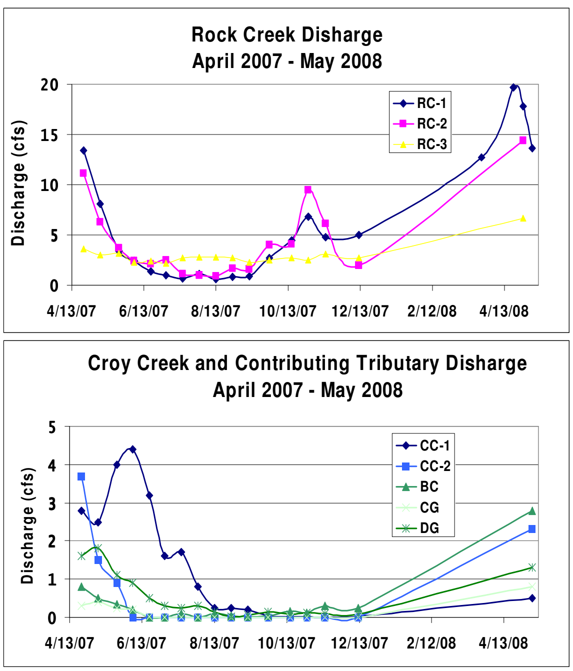

Figure 2. Discharge for all sites.

Flow in the upper portions of these basins are heavily influenced by natural springs and remained relatively constant throughout the summer. Agricultural diversions influence discharge in the lower reaches of these watersheds. In the lowest portions of the basin, water levels diminished quickly by mid-June. Flow dropped to under 1.0 cfs at RC-1 probable due to diversions used to water pastures within the watershed.

Croy Creek was completely dewatered at the upper site (CC-2) and Croesus Gulch (CG) by June 6. Flow in these portions of the watershed did not resume for the remainder of the year. Croy Creek is listed as intermittent between the upper monitoring site (CC-2) and Democrat Gulch. Agriculture irrigation practices and local residential pumping likely effect the amount of surface water available along this reach.

Sediment

Sediment can negatively impact aquatic life. Extended periods of elevated sediment levels can interfere with the ability of fish to feed, damage fish gills, and reduce growth rates. High levels of sediment can also lead to a decrease in available fish spawning and rearing habitat. Sediment can also be a major contributor of nutrients such as phosphorous.

Sediment concentrations in this study were generally highest in the springtime during periods of elevated discharge. Sediment concentrations dropped swiftly as summer progressed and then began rising again in late March 2008 (Figure 3). The maximum sediment concentrations in Rock Creek and Croy Creek recorded during the sampling period were 56.3 mg/L and 11.1 mg/L, respectively. Sediment concentrations were consistently highest at the sites located lowest in both watersheds. This suggests that sediment concentrations are increasing as the water moves down through the basin.

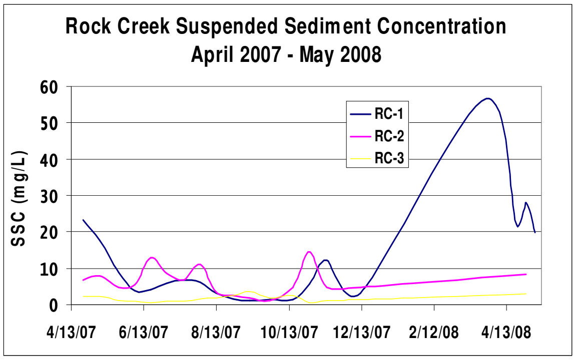

Figure 3. Instantaneous sediment concentrations for the Rock Creek drainage.

The BWR TMDL has set sediment targets for tributaries to the Big Wood River above Magic Reservoir. These targets state that in-stream sediment concentrations should not exceed a daily maximum of 40 mg/L or a monthly average of 25 mg/L. The daily target was exceeded only once in Rock Creek during the spring of 2008 when a sediment concentrations of 53.6 mg/L was observed at RC-1.

Average annual sediment concentrations in both basins were relatively low. The mean annual sediment concentrations at the mouths of each creek were 11.6 mg/L (RC-1) and 4.6 mg/L (CC-1), respectively (Figure 4).

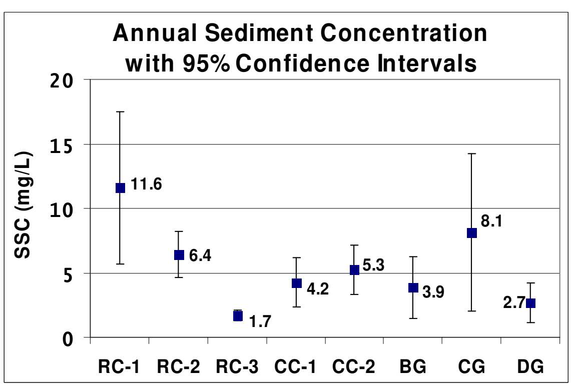

Figure 4. Annual sediment concentrations.

Additionally, IDEQ has determined that the acceptable sediment load capacity for sustaining the current beneficial uses of these streams are 44.3 tons/yr for Rock Creek and 54.1 tons/yr for Croy Creek. Monitoring data from April 2007 through May 2008 determined that the cumulative sediment within the watersheds were 52.8 tons/yr in Rock Creek (RC-1) and 3.1 tons/yr in Croy Creek (CC-1). The significantly lower sediment load in Croy Creek was likely due to the intermittent flow regimen within the middle section of the creek as well as the beaver ponds located near the confluence of Croy Creek with the Big Wood River. These ponds slow down the velocity of the water which allows the suspended sediment to drop out. Therefore, sediment pollution to the BWR from Croy Creek does not seem to be an issue.

Rock Creek sediment concentrations, on the other hand, would need to be reduced 17.5% to meet the established TMDL sediment target. This reduction could easily be met through bank stabilization projects within the watershed. Numerous vertical cutbanks exceeding 4 feet in height are present in the basin. These areas of rapid lateral erosion are particularly prevalent below the convergence of Smith Creek and on Rock Creek between Long Gulch and Hatty Gulch. Riparian plantings, selective fencing, and off-site watering could make significant contributions to reducing soil loss within these areas.

Phosphorous

Total phosphorous is the measurement of all phosphorous, organic and inorganic. A portion of this phosphorus is in a dissolved form and can be readily utilized by plants and can lead to impairment of water bodies if the concentration is high. Elevated concentrations of phosphorous can lead to increases in nuisance algae. When the excess biomass decomposes, additional dissolved oxygen is used which may cause fluctuations that increase fish stress and/or fish mortality. Additionally, excess amounts of algal and plant growth can adversely affect recreational activities on lakes and reservoirs. Additionally, high levels of algae can adversely affect recreational activities on lakes and reservoirs.

The highest TP concentrations were seen in the middle and lower reaches of Rock Creek (Figure 5). The BWR TMDL set the TP target for streams above Magic Reservoir at 0.05 mg/L (Buhidar, 2003). This value was exceeded during 17 monitoring events, or 85% of the time, at RC-1 and RC-2 during the period of monitoring. The target was exceeded for half the measurements taken at CC-1 (n=12), though only marginally.

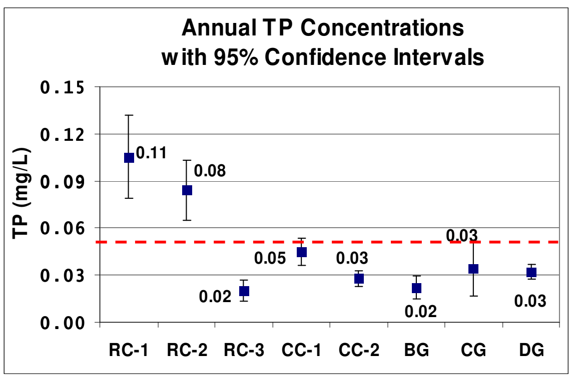

Figure 5. Annual TP concentrations. The dashed red line represents the 0.05 mg/L TMDL target for streams above Magic Reservoir set by IDEQ.

The annual mean TP concentration at the lower site in Rock Creek (RC-1) was more than double the average monthly target set in the BWR TMDL. There seemed to be little correlation with TP concentrations to high discharge and/or elevated SSC concentrations. TP concentrations appeared to decrease with the increase is stream discharge—possibly due to dilution. Although some of the TP present is associated with sediment, the data suggests that the phosphorous is originating from alternate sources.

During the monitoring period, over 60% of all phosphorous in Rock Creek was in the dissolved form. One possible source of the dissolved phosphorous is cattle and wildlife excrement. Experiments conducted by the Utah Department of Environmental Quality have shown that the proximity of cattle grazing to a waterbody can affect its nutrient load. It has been documented that beef cows may excrete up to 25 pounds of phosphorous a year This phosphorous can make its way into the creek through direct deposition and through surface/groundwater returns from irrigated pastures (UDEQ, 2004). Cattle exclusion (fencing) from the stream could help reduce direct phosphorous inputs, while slight modifications in irrigation practices and the placement of berms near the stream could help keep return flow nutrients out of the water.

Bacteria

E. coli is a species of coliform bacteria used by the state of Idaho to indicate the presence of pathogenic organisms. When present in high concentrations, these pathogens can cause sickness or death in humans. They do not have any known effects on aquatic life.

When an *E. coli* measurement exceeds 406 CFUs in a primary contact recreation area, IDEQ requires that five samples be gathered over a 30-day period in order to compute the geometric mean to determine if the water body is meeting state water quality standards (IDEQ 2002). However, since this amount of monitoring was impractical for this monitoring regime, the 406 CFUs instantaneous number will be used merely to illustrate the likelihood of water quality impairment with respect to *E. coli*.

The highest concentrations of bacteria were found in the lowest reach of Rock Creek (RC-1, Figure 6). Bacteria concentrations began to rise in late May at all locations.

The levels generally remained elevated where flow was present as stream temperatures increased through the warm summer months and then began to decrease in early September.

The Idaho State water quality standard for bacteria concentration, 406 CFUs for primary contact recreation, was exceeded at RC-1 for 38% of all samples. Elevated bacteria concentrations in Rock Creek seemed to coincide with elevated phosphorous levels. This would seem to support the theory that animal waste is a major contributor of phosphorous to the system. Exclusion fencing and/or berms to divert return irrigation water from directly reentering the stream would likely reduce bacteria concentrations in Rock Creek as well as reduce nutrient inputs..

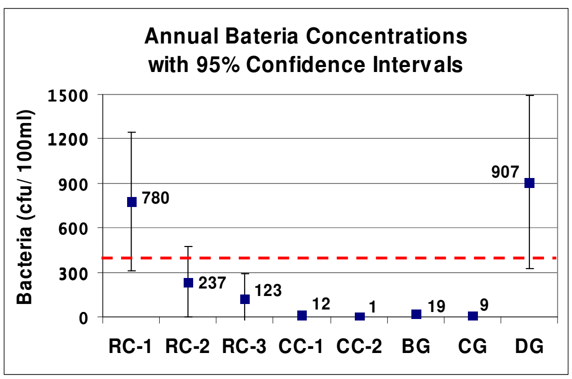

Figure 6. Annual bacteria concentrations. The red line represents the Idaho water quality instantaneous limit for PCR listed streams.

With the exception of Democrat Gulch (DG), whose source is warm geothermal spring water, the Croy Creek watershed had no bacteria exceedances. This is partially due to the upper segment of Croy Creek and Croesus Gulch being dry by mid-June; conversely, Rock Creek showed sustained bacterial impairment throughout the year.

Temperature

State of Idaho water quality standards require that daily maximum temperature must not exceed 22 degrees Celsius and daily average temperature must not exceed 19 degrees Celsius for streams identified as supporting cold water aquatic life (CWAL). With the exception of Democrat Gulch (DG), all temperature measurements met the water quality criteria (Figure 7). Water temperatures at the upper site on Rock Creek (RC-3) also appeared somewhat elevated; however, this is largely because water entering this site originates from a nearby spring.

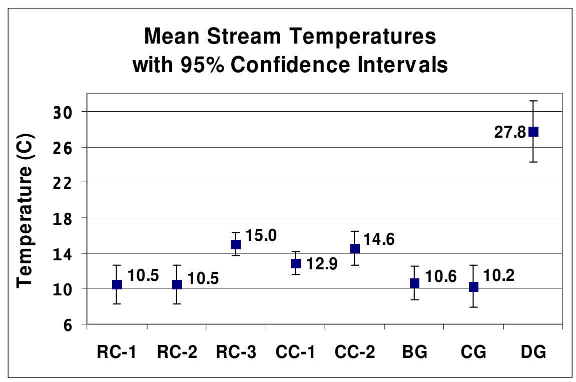

Figure 7. Mean annual instantaneous stream temperature measurements.

Dissolved Oxygen

The state minimum standard for dissolved oxygen is 6.0 mg/L. As with temperature, the only site that dropped below this standard was Democrat Gulch (DG) which had a mean annual value of 5.2 mg/L. This was probably due to the elevated temperature within the waterbody.

Conclusion and Recommendations

This study showed that Croy Creek is meeting the Big Wood River TMDL targets. However, monitoring also identified Rock Creek as a major contributor of sediment, phosphorous, and bacteria in the area. These three pollutants repeatedly exceeded Big Wood River TMDL targets in the Rock Creek subbasin.

Suspended sediment concentrations were elevated during periods of high springtime discharge in Rock Creek. This sediment likely originated from lateral and vertical bank erosion, animal trampling, and pasture irrigation return flow.

Phosphorous and bacteria levels in lower Rock Creek remained high from early June until late August. Sampling revealed that phosphorous was disproportionately present in the dissolved form. This indicates that the major inputs of phosphorous into the system are originating from something other than suspended sediment present in the water column; animal sources are a likely contributor. Temporal corresponding elevations of bacteria reinforce this interpretation. Additionally, although flow alteration was not directly identified in this study, flow reduction due to surface irrigation and groundwater pumping (particularly in the Croy Creek watershed), likely resulted in elevated stream temperatures. This warming effect may have contributed to increases in bacteria concentrations.

BMPs that result in streambank stabilization could reduce erosion. Among others, improved management practices might include exclusion (fencing) and re-vegetation. Mature vegetation could reduce stream access to cattle and other wildlife which adversely impact streambanks and add phosphorous and bacteria to the stream. If exclusion is employed, off-stream watering will need to be employed until streamside vegetation has matured sufficiently. Creating berms along surface irrigated reaches of Rock Creek could reduce the amount of sediment and bacteria entering the stream. In addition to improved water quality within these basins, improving streamside riparian conditions could have positive impacts on local wildlife.

Cited Works

Buhidar, B. The Big Wood River Watershed Management Plan, 2003.

Idaho Department of Environmental Quality. Water Body Assessment Guidance- Second Edition, 2002.

Utah Department of Environmental Quality. Beaver River Watershed TMDL, 2004.